DOCUMENT RESUME

ED 232 262 EA 015 809

AUTHOR Thode, Walter F.; Walker, Richard A.
TITLE A Model for Comparing Training Costs in a Complex Military Training System.
PUB DATE 14 Apr 83
NOTE 51p.; Paper presented at the Annual Meeting of the American Educational Research Association (Montreal, Quebec, Canada, April 11-15, 1983). Some figures and tables may reproduce poorly due to light print of original document.
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Cost Effectiveness; *Cost Estimates; Decision Making; Efficiency; Expenditures; Flight Training; Instructional Development; *Instructional Systems; Life Cycle Costing; *Military Training; *Models; Student Costs
IDENTIFIERS *Navy

ABSTRACT

To assist managers of complex training systems in making decisions that result in changes in the existing training syllabus, this study provides a model for estimating and comparing the costs of training system components and of potential changes to the components. In the first part of the study, this assessment model is broken down into five principal cost categories: (1) instructional systems development (ISD), (2) facilities, (3) training devices, (4) actual equipment trainers (AET), and (5) students. The model is then applied to data available from the P-3 (land-based antisubmarine warfare fixed-wing aircraft) fleet readiness squadron (FRS) aircrew training system. Cost comparisons reveal that ISD costs are minor (1 percent) compared to the total cost of aircrew training. The costs attributable to AET constitute the bulk (75 percent) of the total costs. Second in importance to AET costs is the cost of students (15 percent). The remaining costs of facilities and training devices are 1.5 percent and 7.6 percent, respectively. The study recommends the use of cost assessments prior to training system acquisition or revision. Included are 23 tables of data on P-3 related training system costs. (JBM)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

Walter F. Thode

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

ED232262

A MODEL FOR COMPARING TRAINING COSTS IN A COMPLEX MILITARY TRAINING SYSTEM

Walter F. Thode
Navy Personnel Research and Development Center
San Diego, California 92152

Richard A. Walker
Courseware, Inc.
10075 Carroll Canyon Rd.
San Diego, California 92131

Paper presented at the American Educational Research Association
Annual Meeting in Montreal, Canada on April 14, 1983

Printed in U.S.A.

EA 015 809

INTRODUCTION

Problem

Managers of complex training systems frequently make decisions resulting in changes to the existing training syllabus. In most instances, these decisions are made without a complete understanding of the cost impact of the changes. Training managers often have cognizance of only a small part of the costs of training. Historically, the most readily available cost data have been those associated with the procurement and routine operation of the system hardware (aircraft, training devices, etc.). Other readily available cost data, particularly in recent years, are those associated with developing new training syllabi using the instructional systems development (ISD) process. When costs are considered, only the most visible costs are typically used, and many others which are not so easily documented are ignored.

Objective

The objective of this effort was to develop a cost assessment model that allows training course managers to estimate potential cost impact of any decisions made that affect the syllabus of instruction. The objective of this paper is to describe the model and demonstrate its application.

Background

Few training system managers relate the cost of course development or revision to the cost of an entire training system. They often point to the high cost of training, but are unable to identify or compare all categories of training costs or describe the interrelationships between them. The cost of an ISD effort is often quoted, but the cost figure can seldom be related to other costs within the training system. Two problems exist: (1) What are the relevant cost categories of a training system? (2) What are the cost ramifications when changes occur within these categories?

Numerous cost studies and/or models are available, but each has shortcomings in the areas of training system cost assessment and comparison, particularly with respect to working level use. Doughty, Stern, and Thompson (1976) have developed a guideline for cost analysis in a typical U.S. Navy "A" school, but their study does not adequately reflect the ISD acquisition costs or the costs relevant to the more exotic hands-on media such as flight simulators. They also do not cover multiple training tracks or the interaction of media versus training tracks associated with team or aircrew training. Orlansky and String (1977) present a rather complete generalized model for estimating training costs, but it is not easily applicable to a specific training setting. Allbee and Semple (1980) have developed an extensive cost model using various U.S. Air Force examples. While it renders valuable insights for the development of cost models, the approach is often too detailed for use by individual training activities which lack the required accounting resources.

Existing studies suitable for working level use have other shortcomings. Browning, Ryan, Scott, & Smode (1977) were not tasked to look at any training medium except a particular flight simulator and did not make comparisons beyond one training track. Braby, Henry, Parrish, & Swope (1975) provided

some guidelines for costing media alternatives, but these guidelines are helpful only in isolating costs of conventional media. Goclowski, King, Ronco, & Askren (1978) described a model identifying system ownership costs. Their model is a good reference in attempting to establish a methodology for the identification of cost-related factors in a complex training system, but it is incomplete in other areas. A model for costing a complex training system is needed that will allow meaningful comparisons to be made among categories of costs within the system.

Use of the Model

The present study is not a new approach to cost analysis, but represents a modification of existing models for use at the working level in assessing the relative costs of training alternatives. It should also apply to other military training as well. The model to be presented here is not an optimization model but simply provides a structured means for determining costs of specific training system structures. No systematic attempt has been made to adhere to the Department of Defense (DoD) requirements for conducting economic analyses (Note 1), since this model is intended for use by working level training managers who are not usually in a position to follow those exacting guidelines, but who nevertheless require assistance in assessing the relative costs involved in training system decisions they must make.

An overview of the cost model will be presented to familiarize the user with the cost categories included. Each category will then be discussed and cautions will be given with respect to its use. Finally, an application of the model will be presented, using data from the Navy's P-3 antisubmarine warfare fleet readiness squadron (FRS) aircrew training system.

DEVELOPMENT OF THE MODEL

Cost Model Overview

Figure 1 shows the cost model. Costs are determined for overall cost categories, since in many cases the costs are not available for an individual course, student, or crew except by apportioning costs from the broader categories. Costs for purchase of major training devices or for procurement of training courses developed using ISD methodology are not available except as an aggregate. When a grand total or subtotal is obtained, it is a relatively simple matter to parcel out unit costs.

Insert Figure 1 about here

A close examination of the first four categories in the model reveals that each has the following three potential cost components:

1. Initial cost of procurement
2. Projected life-cycle personnel costs
3. Projected life-cycle nonpersonnel costs.

These components may or may not all apply to a particular training system.

However, each subcategory should be considered in an evaluation to ensure that all possible costs have been included. The description of the model presented here may not specifically address all possible subcategory costs for all applications, so the user must be alert for any other costs and ensure their inclusion.

It is imperative that all relevant baseline conditions and constraints that apply to a particular training system be explicitly stated at the outset. This will ensure understanding and agreement with respect to the outcomes of the cost determination.

ISD Costs

As noted earlier, the cost of curriculum development has recently been isolated from other training costs. Curriculum development costs have often been singled out for close examination. Since all DoD training development must be accomplished through the use of ISD techniques, attention has focused on these techniques. Curriculum development of any kind is expensive, although the costs of traditional techniques are not usually available for comparison. Costs, however, are relative, and seldom have ISD costs been compared to the costs of the other components of training.

ISD Initial Procurement Costs

As manpower availability has decreased, DoD has often turned to civilian contractors for training course development. Contractor costs, since they are usually very visible, are often viewed as the major costs of ISD. However, the cost of the military personnel who will work with contractors, and who may outnumber contractor personnel, must also be included if accurate cost data are to be obtained. Any government civilian personnel costs should also be included. Finally, any miscellaneous ISD costs must be identified and added. Collectively, these categories will provide the initial ISD procurement cost. When all ISD procurement cost factors have been included, the total ISD costs are often orders of magnitude larger than the costs of ISD contractors alone.

ISD Update Personnel Costs

The model provides for past, present, and future costs. Past and present ISD costs can be documented, while it is usually necessary to make some estimate of the costs of future events. Any assumptions made with respect to future costs must be specified, since these assumptions can have a marked effect on the magnitude of these costs. When future costs are estimated, a fixed period for the projections should be chosen to represent the life cycle of the training system, and should be applied to all cost areas in the model. The life cycle chosen should be a reasonable estimate of the longevity of the training system.

Within the category of ISD personnel update costs will be military costs, government civilian costs, and any expected contractor costs. To the extent that personnel are not employed full-time in ISD update activities, the projections of their costs should reflect only that percentage of their time that is spent in those activities. Personnel costs should be based on the authorized billet structure, and not on the actual on-board personnel, who may change over the years. Projections of annual pay increases should be

included. The effects of inflation should be included as well, unless all costs are to be calculated in dollars tied to a particular year. If inflation is ignored, relative rather than absolute costs will be the outcome. In many applications, relative costs of alternative training system configurations will be the most valuable information.

ISD Update Nonpersonnel Costs

Costs in this area are less easily projected. However, if new equipment is required to carry out ISD update activities or to manage and control the updating process, or if outside services are used in the maintenance of the instruction, the costs of these items should be included here. Also, costs of administrative equipment and supplies should be included.

Facilities Costs

In this section the costs associated with the classroom facility are discussed, including initial procurement costs, life-cycle personnel costs, and life-cycle nonpersonnel costs.

Initial Procurement Costs

Building Costs. This refers to the actual building(s) that house the training system. This item may not apply in all applications of the model, since the use of existing buildings incurs no additional costs. However, if a new facility was constructed or an old one modified, these costs should be included.

Facilities Equipment Costs. All equipment such as slide projectors, videotape equipment, specialized furniture (carrels, etc.) are to be included here. If these items existed prior to the training system revision, you may choose to exclude them from the cost comparison.

Facilities Support Equipment Costs. Many commands possess their own print shops, graphics shops, audiovisual studios, and/or other support activities. If these facilities were established as part of the introduction of a training system, or if they were modified or augmented as part of the effort, the costs incurred should be included.

Life-cycle Personnel Costs

Instructor Costs. Instructors are those personnel who actually instruct students in the classroom facility. They may be military or civilian. They may give lectures, conduct seminars, or monitor learning center activities in the case of individualized instruction.

Facilities Staff Costs. The classroom facility staff is defined as all those who are not instructors but who support the instruction, such as printing press operators, librarians, graphics personnel, audiovisual studio personnel, etc. If these personnel spend some percentage of their time on unrelated activities, that percentage of their time should be excluded from the cost projections.

Nonpersonnel Support Costs

These costs should include any items that are consumed by students and require replenishment, such as workbooks, other non-recyclable training materials, pencils, and other supplies. Projected new support equipment, such as printing presses, copiers, word processors, audiovisual equipment, etc., should be included. Any maintenance fees for support equipment, or any other expenses that relate to the classroom facility life cycle but that are not personnel costs, should be included.

Training Device Costs

A training device is defined as a device that was designed specifically to support training. It is not actual on-the-job equipment, but is often a mock-up or replication, with special features built in for the support of training. It could be an aircraft cockpit mock-up that would be used as a cockpit procedures trainer, a computer-driven aircrew team trainer or weapon system trainer, a cutaway model of a ship, a miniaturized fleet on a maneuvering board, a computer-assisted instruction (CAI) system, or any number of other devices used specifically for training. Support equipment items such as slide projectors, movie projectors, or television equipment, are not training devices and are accounted for elsewhere in this model. Training device costs include device acquisition and continuing personnel support costs.

Acquisition Costs

All costs having to do with initial acquisition of the device(s) should be determined. These include costs of both hardware and any software development required. Often hardware costs may be relatively low in comparison to software costs, if complex computers are included. In the case of CAI systems, software costs associated with instructional development are to be included in ISD costs. All other computer software costs should be included in this category. If the training device costs are available only as amortized costs over a period of years, the total of the amortizations should be determined and used as the acquisition cost. If the equipment in question is already available, it is acceptable to consider such equipment as a "sunk cost" and exclude it from cost comparisons.

Continuing Personnel Costs

Training Device Instructor Costs. Instructors use the devices to instruct students going through the training system. Instructor costs over the defined life cycle of the training system must be included here. Both military and civilian personnel costs are required.

Device Maintenance Personnel Costs. All costs for personnel who maintain the devices are required. This category can be sizeable in the case of complex aircraft simulators, but will often be relatively minor. Sometimes the costs will be available only in conjunction with overall training device costs, and will be included in staff reports that are submitted annually.

Nonpersonnel Update Costs

Operating Costs. These costs include all spare parts, energy costs, and

any other routine costs of operating the devices. Also included are any software/reprogramming costs involved with the hardware systems. All costs are needed for the life cycle of the system. Often, these figures are available from the aforementioned staff reports.

Device Modification and/or Update Costs. This is a difficult area for accurate cost determination. Often, there is a plan available that specifies planned modifications, and which provides some estimate of the costs associated with the modification. However, the data often do not cover the life cycle of the training system, and some educated but rough estimate may be the best data available.

Actual Equipment Trainer Costs

Actual Equipment Trainers (AET) are defined as equipment actually used on the job in the accomplishment of the stated mission, and are also used in training. They might include aircraft, artillery, ships, rifles, vehicles, or any other equipment that is used both to carry out the mission and to support training. If the AET is complex, such as aircraft, a complex and expensive maintenance system is probably required to ensure its operation. If an argument can be made that the maintenance system will not change as a result of training system revisions, the costs of maintenance can be excluded.

Many training systems will not include actual equipment costs, if they do not incorporate equipment that is actually used on the job. Even if such equipment is employed, it often is counted as "sunk costs" and not included in the cost data.

Acquisition Costs

It may be that the needed items are already on board, and the costs of acquiring them may be excluded. Although this decision is left to the user, the conditions and assumptions should document any rationale for excluding these costs.

Personnel Operation/Maintenance Costs

These costs must be determined for the life cycle of the system. Costs for both instructors who use the equipment and support personnel who maintain the equipment must be included. Maintenance personnel costs may be omitted from the cost projections if the training revision does not affect operation or maintenance.

Nonpersonnel Operation/Maintenance Costs

This category includes any costs associated with the use of AET that accrue over the life cycle of the system. In the case of aircraft, both fuel and spare parts would be included here. If any equipment is expended in training, such as ammunition or other ordnance, it would also be included. This category should not include modification or update to the AET, unless these modifications are implemented wholly for training purposes.

Student Costs

The military services, unlike many of their civilian counterparts, pay their students undergoing training. This expense must be included within an instructional system's training costs. In order to determine this cost, the number of students who enter training during the life cycle of the instructional system is multiplied by the costs of the students. The cost of a student includes his salary and those overhead expenses that are related to his training up to the time of his entry into the training system being assessed (see Koehler, 1979a, 1979b). It also includes salary, overhead, and any per diem costs during his training within the training system being assessed. It will be necessary to determine the length of time spent in training by each type of student and thereby allocate that part of his annual salary spent in training. It may also be useful to differentiate between the number of students who enter training and the number who complete training, since the cost of dropouts can be significant, and any reduction in that number can represent a significant savings. More interest in reducing the number of dropouts may be generated when the potential cost savings are made more visible.

Other Costs

The five cost categories described in the preceding pages include all relevant costs that are typically incurred in a training system. An attempt should be made to ensure that all costs that can be identified fit into one of the categories given above. However, it is recognized that all training systems are not alike, and that certain cost items may be identified that do not fit into any one of the foregoing categories. When this occurs, those costs should be placed in a miscellaneous category to ensure that they are included in the final cost total. Miscellaneous costs will be easy to inadvertently omit, since they do not fall readily to hand in an existing category of costs. For that reason, all training system components should be reviewed for additional expenses that have not been included elsewhere.

Model Summary

The model presented here was conceived as a generic description of the relative costs of training systems, with the intent that individual users would be able to mold it to their own system. When all blocks of information have been completed, each cost, whether realized or projected, can be compared with the other costs in the model. The user can best determine which cost comparisons are of most relevance to the particular system being evaluated.

APPLICATION OF THE MODEL TO P-3 FRS AIRCREW TRAINING COSTS

This section describes the application of the cost model to the P-3 Patrol Fleet Readiness Squadron (FRS) aircrew training system. It includes certain simplifying assumptions that will be outlined below. This application of the model follows the approach of Orlansky and String (1977) in that it does not display sensitivity to the timing of costs or to budget implications of program alternatives. It serves as a general structure for use by local training system managers to estimate training costs and make cost comparisons.

The P-3 Antisubmarine Warfare (ASW) Patrol FRS aircrew training system was selected to illustrate the model for two reasons. First, it is a complex

training system that exercises most of the facets of the model. Second, a substantial amount of data were available to the authors concerning this system, since it had recently undergone an extensive ISD effort (Long, Freedman, Walker, & Thode, 1982), and many of the costs were identified.

There are two patrol FRSs. Patrol Squadron 31 (VP-31) at the Naval Air Station (NAS) Moffett Field, California, was the primary site of the ISD effort. A parallel instructional system exists at Patrol Squadron 30 (VP-30) at NAS Jacksonville, Florida. These squadrons provide training in specific aircraft systems operation to prospective P-3 crew members in the Pacific and Atlantic Fleets. The FRSs and their respective Fleet Aviation Specialized Operational Training Group Detachments (FASOTRAGRU DETs) each control nearly two dozen aircraft and a large variety of complex training devices and other assets. These assets are used to train over 1500 prospective aircrew members every year.

The FRSs are also responsible for training maintenance personnel. However, since maintenance training was excluded from the ISD effort, it is not included in the present training system cost example, which addresses aircrew training only.

Defining the Scope of the Cost Assessment

Any cost assessment that is carried out must begin with a set of decisions that defines the scope of the effort. These decisions will serve both to guide the cost assessment as it proceeds, and to communicate to others the scope and rationale of the cost assessment. It is always possible to uncover areas of disagreement about what should be included in an exercise of this sort. However, if the scope is defined, other interested parties who are interested in an analysis with a different scope can note the boundaries of one assessment in undertaking another.

The following decisions were made at the outset of the P-3 FRS aircrew training cost assessment:

1. It was deemed impractical to attempt to ascertain the small cost differences among the various models of the P-3 aircraft now in use in the FRS and in operational squadrons. In most instances, the baseline P-3C was assumed to represent the other models, except where specific data were required for the P-3B. The differences among the baseline P-3C, the P-3C Update I, and the P-3C Update II have been ignored.

2. Determining costs for P-3 aircrew training was complicated by the presence of two FRSs. This results in some duplication of resources for which costs must be determined. For purposes of this cost assessment, all cost data from resources that would not be duplicated if only one FRS existed were calculated on the basis of one of the squadrons only. For example, the training devices are available at both FRS sites, but would not have been duplicated if only one FRS existed. Thus, trainer costs were calculated for one FRS only. In other cost areas where resources were drawn from both FRSs but would have been required even if only one had been involved, the costs were totaled for both FRSs and included in the displayed data. For example, in the case of the military staffing costs during the ISD effort, VP-31 provided most but not all of the staff. In order to include all military

staffing costs that would have been required if only one squadron had been involved, the contribution of VP-30 was added.

3. Student and instructor load information have been used from one P-3 FRS only. If all student and instructor quotas were used from both VP-30 and VP-31, the relative cost of those training system components which have not been duplicated (i. e., ISD costs) would decrease. However, this duplication does not serve to illustrate the model as well as a single-sited training system does. Additionally, the costs for a single P-3 site are of interest to many commands.

4. Fifteen years has been somewhat arbitrarily chosen as the life cycle of this training system. This life-cycle figure has been used throughout this application of the model. Another figure might easily be chosen, but the fifteen year figure appears in other P-3 FRS data, and seems to be a reasonable figure for P-3 FRS training system longevity.

5. Due to the lack of data, costs were not identified for instructor training that occurred prior to assignment to the P-3 FRS. This category is negligible in the case of the P-3 FRS. It may be more significant, however, in other applications of the model. As more specialized instructional skills are required of instructors, the training they require will become a more significant factor in total costs.

6. In the case of the P-3 FRS environment, student attrition is very low, and is not a significant factor in training costs. In order to simplify the model application, student attrition is assumed to be zero. For a more complete discussion of attrition, see Orlansky & String (1977).

7. A number of P-3 flights are taken that could have been included in the flight hour figures for training of FRS students. These include administrative flights, flights aborted due to equipment malfunctions, out-of-maintenance check flights, instructor instrument check flights, and a number of others. Data on these is difficult to obtain, however, and the degree of student training that occurs on them is not significant. Therefore, none of these have been included as student flights.

8. Costs have not been established for some student categories such as second tour naval flight officer (NFO), second tour flight engineer, Naval Air Rework Facility (NARF) test pilot, or others that occur rarely.

9. The overhead of indirect administration of FRS training would include squadron, wing, type commander, and FASOTRAGRU DET administrative and headquarters costs. These could have been included in cost data, but the relative costs between categories would probably remain unchanged. Thus, these have been eliminated. Allbee and Semple (1980) provide an example of Air Force training costs that does include costs of some of the headquarters in the chain of command.

10. Costs are assumed to be in constant dollars, based on the 1977-1978 time frame. It is obvious that the effects of inflation in the current environment make absolute cost data somewhat difficult to interpret. However, for the purposes of this model, relative costs across categories are more important than absolute costs. The relevant information in this cost

assessment is the relative impact of costs in one category as compared to another. The violation of the guidelines provided in the applicable Department of Defense Instruction (DODINST 7041.3, Note 1) for carrying out cost analyses is recognized, but it is felt that total adherence to those guidelines would require a degree of complexity that would make this model application less useful for P-3 FRS training managers, who would be less likely to use a complex model.

11. A significant effort in maintaining the curriculum of a complex training system is expected. Walker (1978) showed that over a two-year period in the Navy's S-3A FRS training system, 22 percent of the learning objectives required change due to content, learning strategy, or media-related issues. A similar effort is projected for the P-3 FRS curriculum.

As the model is illustrated below, further discussion of some of these governing data will be presented, in connection with the discussion of specific cost areas in the model.

Gathering Baseline Data

In order to apply the cost model, baseline information on several variables is required to establish the extent of the instructional load. Two such variables are discussed here. The utility of the baseline data will be seen in subsequent sections as the data are manipulated and used in the determination of cost figures.

Student Load

The determination of student quotas for use in applying the model was based on VP-31 Notice 1500 (Note 2). The quotas are presented in Table 1. Data for one class, for one year (ten classes), and for the fifteen year life cycle are given.

Insert Table 1 about here

Description of the P-3 Master Course Syllabus

The P-3 Master Course Syllabus (MCS) (Patrol Squadron 31, 1979) describes each hour of P-3 aircrew instruction for all media and all aircrew positions. Crew positions are described by type of aircraft (P-3B or P-3C) as well as by job title. The MCS is summarized in Table 2. The number of instructional objectives for each crew position is taken from a VP-31 letter (Note 3). The media shown include learning center activities, the numerical designations of training devices and simulators, and the P-3 itself.

In order to determine the costs of instructors in each of the various instructional media in the P-3 FRS, the ratio of students to instructors must be defined. Table 3 shows the instructor-to-student ratio required by various generic hands-on media. These ratios will be used to determine instructor cost in these media categories. Another set of data that will be required is the proportion of each training flight hour that can be attributed to student training in each training track. This relationship depends both on the MCS

phase and crew position. Table 4 shows the allocation of flight hours by position that was used.

Insert Tables 2, 3, and 4 about here

Estimating P-3 FRS Training Costs

At this point the cost assessment exercise for the P-3 FRS training system begins. Each of the five main cost areas will be addressed in turn. For convenience, all costs will be rounded to the nearest thousand dollars.

ISD Costs

The costs required to develop the present curriculum are presented in this section. They are categorized into initial procurement, personnel update, and nonpersonnel update costs.

Initial Costs of Procurement. The initial contractor costs for the ISD efforts totaled $2,948,000. The P-3 ISD team personnel costs shown in Table 5 were developed from Welch (Note 4) for the staffing and person years, and by using Koehler (1979a, 1979b) for the billet costs. The research psychologist/educational specialist person years and billet costs were taken from NPRDC records.

Insert Table 5 about here

The total ISD procurement costs include the contractor costs and the ISD team costs noted above, and a category of other media costs that accounts for all audiovisual services performed by the Navy, and also for reproduction costs of the audiovisual productions. The source for these data is an NPRDC letter (Note 5).

The total procurement costs determined here apply to both P-3 FRSs, VP-30 and VP-31. This cost is $7,962,000. For VP-31 alone, the cost is half of that figure, or $3,981,000.

Personnel Update Costs. As noted, a significant effort is projected in the maintenance of the P-3 curriculum. The initial implementation and establishment of the system has proven to require a significant outlay of resources. It appears, however, that the routine updating of curriculum items has begun to decrease as the system has been "shaken down," and that the amount of updating will continue to decrease over the remaining years in the system's 15-year life cycle until only the changes resulting from outside influences (the revisions in equipment and reference materials upon which the curriculum is based) are being made. It is assumed that the required staff for this instructional system will decrease in five-year increments. The projected yearly staff costs for the first five years are shown in Table 6. Similar projections are shown in Table 7 for the second five years, and in Table 8 for the final five years. This staffing plan is based on recommendations developed by Walker (1978), and on data presented in an NPRDC

letter (Note 6).

Insert Tables 6, 7, and 8 about here

The military billet costs in these tables have been reduced by a factor of 0.58 to 1, to account for a required division of military work time between ISD revision/update duties and normal military responsibilities (Note 6). Each military member of the ISD staff was able to devote 145 working days per year to ISD revision/update duties, out of the 250 working days in a year. Other military duties, flying responsibilities, vacation, and other duties account for the remaining days. This division of responsibilities for military personnel is projected throughout the system's life cycle.

Table 9 provides a summary of the total personnel update costs for the ISD update efforts over the system life cycle. The total computed cost is $5,933,000 for the total effort, or $2,967,000 for the VP-31 portion.

Insert Table 9 about here

Nonpersonnel Update Costs. No significant costs have been identified in this category. There will be some costs associated with update of curriculum items. These costs will be limited to the costs of the consumable supplies required to complete the items, since a print shop, a television studio, and all other high cost items were funded out of the initial ISD funds. The costs of paper, replacement videotape, and other such items has been included with the costs for learning center nonpersonnel support costs, provided below.

ISD Cost Summary. The total ISD costs were developed by adding the procurement and update costs for the Moffett Field portion of the effort. The summary of all costs in this category is shown as Table 10. The total cost for the VP-31 FRS training system was $6,948,000.

Insert Table 10 about here

Facilities Costs

FASOTRAGRUPAC maintains a learning center (LC) facility at Moffett Field, and the only facilities costs relevant to this exercise are those related to its operation. Both VP-31 and FASOTRAGRUPAC provide instructors to support the LC. The costs for the LC have been identified as follows.

Initial Procurement. The LC has 198 carrels, some of wich hare mediated with slide-tape or videotape equipment. The military construction (MILCON) and equipment costs that occurred as part of the P-3 FRS ISD effort totaled about $600,000. The reader is referred to Allbee and Semple (1980) for a further discussion of MILCON costs.

LC Personnel Support Costs. The cost categories for LC support personnel

are: graphics personnel, text reproduction/duplication personnel, and LC staff. Since both VP-31 and FASOTRAGRUPAC provide instructors to the LC at different times, depending on student progress in the MCS, a full time instructor per student category is present in the LC. Refer to Table 3 for rank and cost data displayed by crew position for each of the seven student categories.

Table 11 shows the total costs for instructors in the LC, based on the instructor cost data in Table 3, the student load, the number of hours in the LC, and the assumed life cycle of the LC. This cost totals $4,126,000.

Noninstructor personnel required in the LC are responsible for update and reproduction of the audiovisual and printed instructional materials, and the maintenance of the LC Instructional Materials Library. Table 12 shows the cost of these personnel. The fifteen-year life-cycle costs total $4,889,000. The costs shown here were obtained from FASOTRAGRUPAC (Note 7).

Insert Tables 11 and 12 about here

FASOTRAGRUPAC routinely reports military costs in accordance with the composite standard military rate table. This table accounts for pay and allowances. However, other costs are associated with individual billets, including the administrative staff costs of an organization, the costs to train an individual to perform his/her present job, and other such factors, must also be considered. These additional costs, which are referred to as overhead, are included in other assessments of billet costs (Koehler, 1979a, 1979b). For instance, the costs to train a pilot are included in the billet cost of a pilot, and the training costs to produce an NFO are included in his billet costs. If the standard military rate table is used for a lieutenant, it shows yearly cost to be $24,611. Koehler (1979b) includes data for both pilot and NFO lieutenants, and indicates the billet costs as $75,347 and $29,198, respectively. Billet costs for government civilian jobs are under development (Koehler, 1980), and will be similarly more inclusive. The FASOTRAGRUPAC figures for overhead for civilian personnel appear to be too low by as much as 20 percent. However, the decision was made to use the data as they were provided.

LC Nonpersonnel Support Costs. The FASOTRAGRUPAC fifteen-year budget figures for nonpersonnel related costs, which includes supplies and equipment costs, were determined by FASOTRAGRUPAC to be $900,000. This figure includes ISD update nonpersonnel costs, as noted previously.

Learning Center Cost Summary. Table 13 shows the total cost of the LC, including initial procurement, personnel costs, and nonpersonnel costs. The total is $10,515,000.

Insert Table 13 about here

Training Device Costs

The three potential cost components for training devices are: acquisition, life-cycle personnel, and life-cycle nonpersonnel costs. Allbee and Semple (1980) discuss in their model an elaborate method for estimating training device costs in an Air Force setting. Orlansky and String (1977) use a simpler approach to arrive at the same kinds of costs. Browning et al. (1977) estimate the costs of devices required for pilot training only. For simplicity, the form of the Orlansky and String model has been used.

Training Device Acquisition Costs. Table 14 shows the training device acquisition and operation costs. The unit prices were obtained from the Chief of Naval Education and Training (CNET) Directory of Naval Training Devices (1978). Again, fifteen years is the assumed life of the devices. The operating hours were reported by FASOTRAGRUPAC. As Table 14 shows, the total cost of $28,200,000 was determined. It might be concluded by some readers that these costs should be ignored, since they are "sunk costs" and not likely to change significantly no matter what the nature of the rest of the training system. However, in this instance, the particular design of the devices dictates their use to a large degree, and a change in the training system might dictate different devices with different capabilities. Thus, it seems relevant to use the costs in this assessment, especially if a comparison with an alternative configuration is planned.

Personnel Life Cycle Operation/Maintenance Costs. The costs of instructors who teach in the P-3 training devices are shown in Table 15. These costs, which totaled $8,491,000 for the fifteen-year life cycle, are based on the student load, the hours of use from Table 2, and the cost per instructor and instructor/student ratio from Table 3. Noninstructor personnel costs are not available separately, but are given as part of the annual operation/maintenance costs for FY 1979 reported by FASOTRAGRUPAC. These costs are projected over fifteen years and are shown in Table 14. The total cost here is $17,550,000.

Insert Tables 14 and 15 about here

Nonpersonnel Life Cycle Operation/Maintenance Costs. These costs are not easily obtainable as separate figures, but are included in the annual operation/maintenance costs given in the preceding paragraph.

Training Device Cost Summary. Table 16 shows a summary of the total costs in the training device category. The final cost is $54,241,000.

Insert Table 16 about here

Actual Equipment Trainer Costs

In this category, the costs are given for the use of the P-3 aircraft as an instructional device or actual equipment trainer (AET), both in the air during training flights and as an aircraft lab on the ground.

Acquisition Costs. The initial cost of the aircraft is obviously the

main cost in this category. Various references are available for the initial aircraft cost. One readily available, from Orlansky and String (1977), shows acquisition cost per P-3 aircraft to be $8,280,000. This figure, multiplied by the number of VP-31 aircraft, would give the acquisition cost. As noted earlier, however, these costs will be ignored in applying this model, since the acquisition has already occurred, and the costs will be the same whether or not the instructional system is revised. (It is conceivable that a decision to remove aircraft from an FRS could be made with data showing that instruction could occur with fewer aircraft, but a decision of this kind is viewed as extremely unlikely.)

Personnel Operation/Maintenance Costs. Two main categories of costs are included here: (1) the costs of instructors who use the aircraft as an instructional medium, and (2) the costs for aircraft maintenance personnel. Data for instructors are given in Table 17, and these costs total $16,445,000 for the life cycle. These data are based on student load, the hours of use required by the MCS shown in Table 2, and the required instructor/student ratio and the cost of instructors from Table 3. Personnel maintenance costs are not easily available, but it is likely that these costs will not differ markedly no matter what the instructional system looks like. Thus, they too have been ignored.

Insert Table 17 about here

Nonpersonnel Operation/Maintenance Costs. The cost per hour for the P-3C aircraft was determined from the NALCOMIS report (Naval Air Systems Command, 1979). The total annual flying hours for the P-3C for 1979 was determined to be 104,863. The total aircraft support costs less petroleum, oil, and lubricants (POL) and training support was estimated to be $155,257,000. This figure, divided by the number of annual flight hours, results in a per hour operation/maintenance cost without POL of $1,480. This is the cost of a P-3C aircraft per hour when used on the ground as an aircraft lab. The Commander, Naval Air Forces, Pacific (Note 8) report of cost of POL per flight hour is $951. The total cost per flight hour is the sum of the two figures, or $2,431.

A fifteen-year training system life-cycle total cost can be determined by multiplying each student's flight hours and aircraft lab hours, from Tables 2 and 4, by the number of students, and multiplying these figures by the respective costs per hour for each track. Table 18 provides this information for aircraft flight hours, and Table 19 provides similar data for aircraft lab hours. The total cost of the two kinds of aircraft usage is $523,629,000. Again, a case can be made that these costs are not relevant to comparative training system costs, since they do not vary significantly with training system changes. However, the aircraft use might well change with training system revisions. For this reason, these costs will be included.

Insert Tables 18 and 19 about here

AET Cost Summary. The total AET costs are shown in Table 20. The total

cost is $540,074,000.

Insert Table 20 about here

Student Costs

Life-cycle student costs were obtained by multiplying the life-cycle student load in each category by the annual billet cost (Koehler, 1979a, 1979b), and multiplying that figure by the proportion of the year spent in training. For example, a first-tour pilot is assumed to be an ensign, and his track length is 99 days out of 250 instructional days available in a year. The cost for first tour pilots is then the annual billet cost of one pilot, times 99/250ths of a year, times the number of first-tour pilots trained in the fifteen-year life cycle. In the P-3 example, eight student categories have been determined, the seven referred to previously in Table 4, and an additional category for second tour pilots. Table 21 shows the data, and provides a student cost figure. The life-cycle student cost is $104,048,000.

Insert Table 21 about here

Other Costs

No other costs were determined for the P-3 FRS example.

Summary

The data collected here include all of the relevant costs for P-3 FRS aircrew training. The total costs across all categories are shown in Table 22. The total P-3 FRS aircrew training system cost is estimated to be $715,826,000. Note that the definition of scope noted at the outset of this exercise has played a significant role in the final dollar amount. If a different scope were chosen, the outcome could be substantially different. For any system with the same scope, however, direct comparisons of cost should be possible from one configuration to another.

Figure 2 shows the complete cost model applied to P-3 FRS aircrew training.

Insert Table 22 and Figure 2 about here

DISCUSSION

Once the cost model has been applied, a considerable body of data is available for examination and comparison with other training system cost data. The following discussion is not intended to be complete in its coverage of all possible implications of P-3 FRS training costs, but is illustrative of the kinds of comparisons that can be made.

Internal System Cost Comparisons

One immediate comparison that can be made is that of relative costs of components of a training system. A summary of the P-3 FRS training system component cost figures, and the relative cost of each component to the total cost, is shown in Table 23.

Insert Table 23 about here

One notable comparison is that the costs of P-3 ISD activities are minor when compared to the total cost of P-3 FRS aircrew training. This is true even though their impact on overall costs can be significant, since by judicious application of ISD techniques the possible reductions in costly areas can be substantial. This is, in part, a reflection of the effect of determining costs across the assumed life cycle of the training system. The potential impact of ISD-related activities on other cost areas will be detailed below.

At over 75 percent, the costs attributable to AET are a substantial percentage of the total costs. Even so, the percentage of the total would have been greater if some of the costs in this category had not been ignored for reasons noted. Costs would be relatively high in this category no matter what the configuration of the training system. Of interest here also would be the relative equipment costs if alternative training system configurations were priced and examined. Obviously, with the bulk of the cost centered in this category, the opportunity for savings is greatest here. If even a small reduction in the number of flight hours required by the syllabus can be achieved, the savings could be enormous.

Similarly, the costs associated with training devices are, at 7.6 percent, somewhat lower than they would be if all possible training device costs were included. Since overall costs are much less than in the case of aircraft-related costs, potential savings would be less dramatic but still significant. In fact, cost savings may be more easily realizable in this area and in other areas that do not have such a high overall cost as AET. In training systems requiring AET assets, a given level of AET is probably required in any system configuration, whereas the development of, and capabilities required in, a training device may vary considerably depending on the degree and nature of the training need. With careful front-end analysis, it may be possible to include in training devices only those capabilities required for training, and thereby reduce costs substantially.

A surprising finding is the high cost of students. Although costs here too are minor in comparison with AET costs, they comprise the second largest cost category. If a fifteen-year life cycle is assumed, as here, student-related costs are nearly 15 percent of the total. In a training system with less expensive AET requirements, the costs associated with students are likely to comprise the largest single cost category. This area, too, may be more amenable to cost reductions than some others as a result of careful application of ISD techniques. In the P-3 FRS aircrew training system, any effort that can be focused toward reducing student-related costs, or

conversely to increase the number of students trained during the system's life cycle, would seem to be warranted.

The primary way in which a reduction of student-related costs could occur would seem to be the reduction in length of various parts of the P-3 MCS. This, of course, would have to occur without any deletion of the critical content being taught. If any savings in MCS time can be realized, a significant dollar savings is possible. One small example should suffice to illustrate this point. If the current MCS first tour pilot syllabus were reduced in length from 99 to 98 days, with no other change in the training system, the life-cycle cost savings would amount to over $125,000.

When the existing P-3 FRS MCS was developed, little effort was made to reduce course length. If overall cost savings are deemed a worthwhile goal, an effort aimed at making the subject matter more compact and efficient, and thereby reducing MCS length, would be worth a sizeable investment.

The other costly areas of the P-3 FRS aircrew training system involve equipment and the personnel who use the equipment, both training devices and aircraft. The two nearly equal components of that cost are initial procurement of the training devices, and the more significant costs attributable to personnel who maintain and instruct using both training devices and aircraft. Instructional science has evolved to the point where input into both of these areas can reap cost savings.

Often in the past, training device design has occurred without due consideration of purely instructional requirements. In some cases, devices are built with an eye toward making them as "realistic" as possible, partly because a need is felt for ensuring that all critical training attributes are addressed. Unfortunately, adequate techniques were not previously available to allow the selection of these attributes. To the extent that we can now specify these attributes and design training devices accordingly, savings are possible in both initial procurement costs and in instructor and maintenance personnel requirements.

The likelihood that cost reductions can be realized by reductions in the amount of equipment use is less in the case of an existing complement of AET than when new AET is being purchased. In the case of a P-3 FRS, the tendency will be to continue the dependence on the available resource of P-3 aircraft to a great extent. However, if it were feasible to substitute properly designed training devices and other instructional events for some of the training activities that now occur on the aircraft, a very significant savings in overall training costs would be possible.

If a completely new training system is being developed, the situation is somewhat different. Specification of instructional events from scratch, with no preconceived needs or existing training structure, could occur in such a way that a much less costly system could result. Some efforts to do this with emerging weapon systems are underway, for example, in the case of training analysis for the proposed replacement Navy pilot trainer aircraft, the VTX.

Unit Costs

A number of specific cost figures are calculable, once the mass of data

given in the preceding pages has been collected. Examples include:

1. Average cost per student. The total life cycle cost for P-3 FRS aircrew training ($715,826,000) can be divided by the total number of students in the life cycle (11,700) to obtain the average cost per student ($61,182).

2. Average life-cycle cost per hour of instruction. The total life-cycle ISD cost ($6,948,000) can be divided by the total number of hours of instruction (3,946) prepared to obtain the average life-cycle cost per hour of instruction ($1,760).

3. Average life-cycle cost per objective. The total life-cycle ISD cost ($6,948,000) can be divided by the total number of instructional objectives (5,722) to obtain the average life-cycle cost per objective ($1,214).

4. Average cost per crew. The average cost per student ($61,182) can be multiplied by the number of students per crew (9) to obtain the average cost per crew ($550,635).

It is clear that a number of other calculations are possible. For example, with the data at hand it would be possible to determine the precise percentage of each cost area attributable to each course by using course length as a determinant, and thereby move beyond average student costs. However, these kinds of cost figures cannot be determined without the basic costing exercise that is the topic of this report.

Utility of a Cost Model

The precise specification of a major weapon system's training support requirements is a complex process. The costs involved are not always clear to planners or managers since they cross budgetary lines of control. It is hoped that a model such as the one presented here can assist planners in estimating the relative impact component costs can have on the total costs of training. A model such as this, which is specifically tailored for collection of data in order to support decision making in working level units, seems to be warranted. However, this report covers only the potential cost impact of training system alternatives. The relative benefits of cost decisions should also be examined, but is beyond the scope of this report. The model presented here discusses only the cost side of a more complete costs/benefits model.

Training system component changes can have unexpected impact on cost. Revisions in one category may cause significant changes in another. For example, a major aircraft system change could cause a revision of all training involving that system, including classroom syllabus components, facilities, training device/simulator training and equipment modifications, and possible changes in student on-board requirements. It is conceivable that new facilities or training devices might be required. If all possible changes and their accompanying costs can be anticipated and included in up-front planning, the full ramifications of the changes can be realized so that sufficient funding can be identified to properly modify the training system. Alternatively, on the basis of more complete information, it may be decided that the proposed modification is not cost effective, given the total cost impact of its implementation.

It is important that training managers understand how a change in a component of a training system may generate a host of downstream changes affecting the total system. If information can be provided that will allow accurate projection of the costs of new or revised training system components, better informed training system management decisions will result.

CONCLUSIONS

1. This model or a similar one appears to be useful in accounting for and/or planning for relative training costs in a complex weapon system.

2. It appears that cost savings can result when cost considerations are examined during the revision of a training system.

3. The model can be applied both to the development of new training systems and the revision of existing systems.

4. The costs involved in ISD in a complex training system are relatively minor in comparison to other costs that are not usually considered in training system revision.

RECOMMENDATIONS

1. Relative cost determinations such as those illustrated with regard to the P-3 FRS aircrew training system should be carried out prior to the acquisition of a new training system or the revision of an existing training system.

2. If the model presented in this report is applied by other users, the results of the application should be made available to the authors to facilitate revision of the model.

APPENDIX:
LIST OF ACRONYMS AND ABBREVIATIONS

A/C	aircraft
AET	actual equipment trainer
ASW	antisubmarine warfare
CAI	computer-assisted instruction
CNET	Chief of Naval Education and Training
Comm	Communicator
DODINST	Department of Defense Instruction
FASOTRAGRU	Fleet Aviation Specialized Operational Training Group
FE	Flight Engineer
FRS	Fleet Readiness Squadron
ISD	instructional systems development
LC	learning center
MCS	Master Course Syllabus
NARF	Naval Air Rework Facility
NFO	Naval flight officer
NPRDC	Navy Personnel Research and Development Center
OFT	operational flight trainer
Ord	Ordnanceman
P-3 (P-3B, P-3C)	land-based ASW fixed-wing aircraft
POL	petroleum, oil, and lubricants
S-3	carrier-based ASW fixed-wing aircraft
SME	subject-matter expert
SS-1/2	Sensor Station 1 and 2 operator
SS-3	Sensor Station 3 operator
USNR	U. S. Naval Reserve
VP-30	Patrol Squadron 30
VP-31	Patrol Squadron 31
WST	weapon systems trainer

REFERENCE NOTES

1. Economic analysis and program evaluation for resource management (Department of Defense Instruction 7041.3). Washington, D. C.: Office of the Assistant Secretary of Defense (Comptroller), 18 October 1972.

2. Patrol Squadron 31 Notice 1500 of 20 Apr 1978.

3. FMS case JA-O-BHS; P & B for P-3C ISD master course syllabus. Patrol Squadron 31 letter serial 524 of 2 Nov 1979.

4. Welch, J. LCDR, USN. Personal Communication. March 1980.

5. Media production resources for P-3 ISD. Navy Personnel Research and Development Center letter serial 3301 of 23 May 1977.

6. P-3 ISD follow-on support requirements. Navy Personnel Research and Development Center letter serial 455 of 14 Aug 1978.

7. FASOTRAGRUPAC San Diego staff members. Personal Communication. April 1980.

8. POL costs per hour: FY 1980. Commander Naval Air Forces, U. S. Pacific Fleet. February 1980.

REFERENCES

Allbee, K. E., & Semple, C. A. Aircrew training device life-cycle cost and worth of ownership (CRG TR-3041E). Westlake Village, CA: Canyon Research Group, February 1980.

Braby, R., Henry, J. M., Parrish, W. F., & Swope, W. M. A technique for choosing cost effective instructional delivery systems (TAEG Rep. No. 16). Orlando, FL: Training Analysis and Evaluation Group, April 1975.

Browning, R. F., Ryan, L. E., Scott, P. G., & Smode, A. F. Training effectiveness evaluation of device 2F87F, P-3C operational flight trainer (TAEG Rep. No. 42). Orlando, FL: Training Analysis and Evaluation Group, January 1977.

Doughty, P. L., Stern, H. W., & Thompson, C. Guidelines for cost effectiveness analysis for navy training and education (NPRDC Tech. Rep. 76TQ-12). San Diego: Navy Personnel Research and Development Center, July 1976.

Goclowski, J. C., King, G. F., Ronco, P. G., & Askren, W. B. Integration and application of human resource technologies in weapon system design (AFHRL Rep. TR 78-6). Brooks AFB, TX: Air Force Human Resources Laboratory, March 1978.

Index to directory of Naval training devices, cognizance symbol "20". Orlando, FL: Naval Training Equipment Center, September 1978.

Koehler, E. A. Life-cycle Navy enlisted billet costs--FY 1979 (NPRDC Spec. Rep. 79-13). San Diego: Navy Personnel Research and Development Center, March 1979.

Koehler, E. A. Life-cycle Navy officer billet costs: An interim report (NPRDC Spec. Rep. 79-20). San Diego: Navy Personnel Research and Development Center, May 1979.

Koehler, E. A. Navy civilian (civil service) billet costs--FY 1980: An interim report (NPRDC Spec. Rep. SR 80-19). San Diego: Navy Personnel Research and Development Center, June 1980.

Long, K. T., Freedman, C., Walker, R. A., & Thode, W. F. Instructional systems development for P-3 aircrew training (NPRDC Tech. Rep. 82-51). San Diego: Navy Personnel Research and Development Center, July 1982.

Master course syllabus by track. NAS Moffett Field, CA: Patrol Squadron 31, April 1979.

Orlansky, J., & String, J. Cost effectiveness of flight simulators for military training (IDA Paper P-1275). Arlington, VA: Institute for Defense Analysis, August 1977.

Total support system report (NALCOMIS-OTS/VAMOSE-AIR). Washington, D. C.: Naval Air Systems Command, 1979.

Walker, R. A. Post hoc evaluation of S-3A instructional systems development plan. San Diego: Courseware, Inc., 1978.

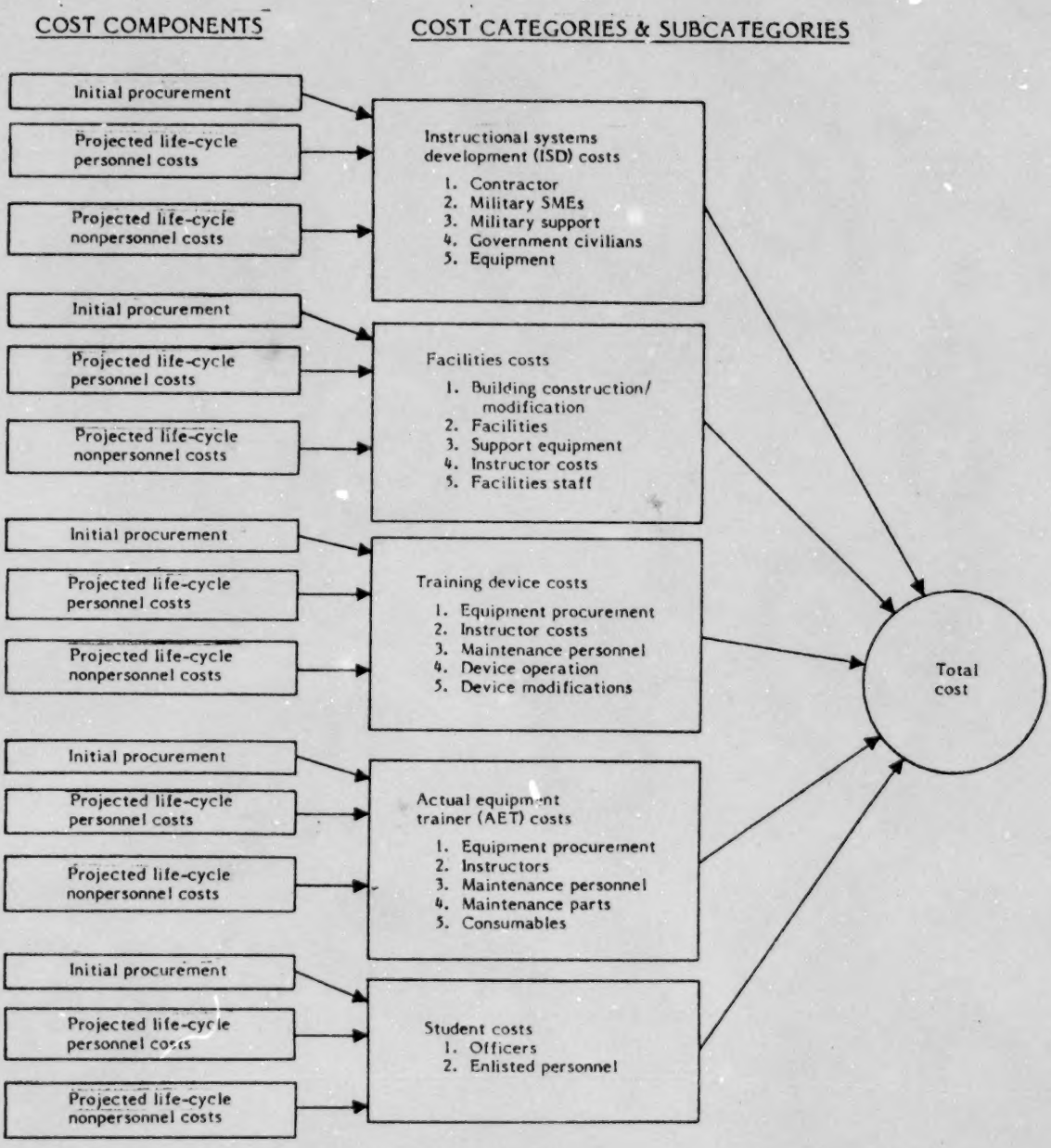

Figure 1. Typical training system cost model.

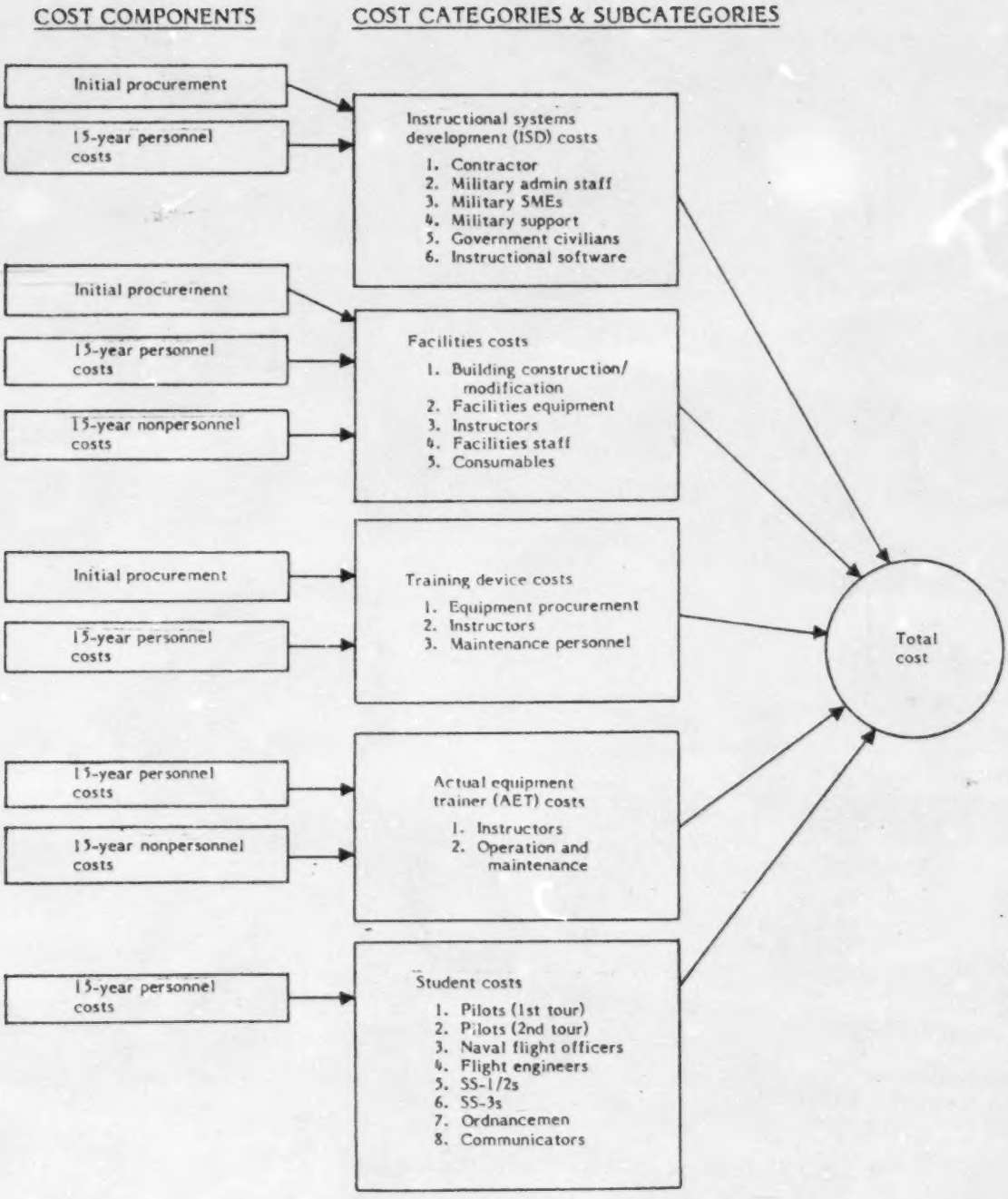

Figure 2. P-3 FRS aircrew training system cost model.

Table 1

Projected Student Load at VP-31

Aircrew Position	Class Quota	One-year Load	15-year Load
Pilot (1st Tour)	15	150	2250
Pilot (2nd Tour)	3	30	450
Flight Engineer	14	140	2100
B NFO	4	40	600
C NFO	8	80	1200
B SS-1/2	4	40	600
C SS-1/2	8	80	1200
B SS-3	2	20	300
C SS-3	4	40	600
B Ordnance	4	40	600
C Ordnance	8	80	1200
B Comm	4	40	600
TOTAL	78	780	11700

Table 2

Summary of Master Course Syllabus (MCS) Hours

Crew Position	No. of Objec -tives	Syllabus Hours by Medium											P-3 Flight	
		Learning Center	2C45/ 2F69F	2F87F	2F87T	2F69T	14B44	14B40	15Z1	15E16	Static A/C	A/C Lab	Phase B	Phase C, D
Pilot (1st tour)	1,000	248	22	28	32	--	3	--	--	--	--	--	20	75
Pilot (2nd tour)	--[a]	239	9	30	32	--	--	--	--	--	--	--	15	35
FE[b]	413	265	8	36	--	--	--	--	--	--	11	--	40	64
B NFO[c]	843	252	--	--	--	69	--	--	--	--	--	21	--	70
C NFO[c]	869	386	--	--	74	--	--	--	--	--	--	27	--	54
B SS-1/2	575	236	--	--	--	32	57	--	--	--	--	20	--	36
C SS-1/2	605	229	--	--	32	--	54	--	--	--	--	35	--	30
B SS-3	298	98	--	--	--	32	--	--	9	11	--	26	--	70
C SS-3	366	154	--	--	32	--	--	36	--	--	--	25	--	70
B Ord[b]	199	44	--	--	--	--	--	--	--	--	33	18	--	24
C Ord[b]	209	40	--	--	--	--	--	--	--	--	31	15	--	24
B Comm	345	130	--	--	--	--	--	--	--	--	17	51	--	30
Total	5,722	2,321	39	94	202	133	114	36	9	11	92	238	75	582

[a]Pilot first and second tour objectives not differentiated.

[b]NAMTRADET training not included.

[c]Tactical team training not included.

Table 3

Instructor/Student Ratio and Cost per Instructor Hour
for All Forms of Instructional Media

Instructor/Student data is given in terms of the number of instructors/ the number of students to that instructor. Cost per hour is based on Koehler (1979a, 1979b) and on 1800 instructor labor hours per year.)

		Type of Training Medium							
		LC		OFT/PT		WST		P-3	
Position & Rank/Rate	Cost/ Year($)	Ratio	$/hr	Ratio	$/hr	Ratio	$/hr	Ratio	$/hr
Pilot (LT)	75,347	1/18	2.32	1/2	20.93	1/2	20.93	1/1	41.85
NFO (LT)	29,189	1/12	1.35	1/1	16.22	1/1	16.22	1/1	16.22
FE (AD1)	28,034	1/14	1.11	1/2	7.79	1/2	7.79	1/2	7.79
SS-1/2 (AW1)	23,138	1/12	1.07	1/4	3.21	1/2	6.42	1/2	6.42
SS-3 (AW2)	18,662	1/6	1.72	1/2	5.18	1/1	10.37	1/2	5.18
Ord (AO2)	18,602	1/12	0.86	-		-		1/2	5.17
Comm (AT2)	23,622	1/4	3.28	-		-		1/2	6.57

Table 4

Crew Members Trained per Flight Hour by MCS Phase

(Proportion of each flight hour assignable to each crew member)

Crew Member	MCS Phase			
	A	B	C	D
Pilot	-	0.5	-	0.14
NFO	-	-	-	0.14
FE	-	0.5	-	0.14
SS-1/2	-	-	-	0.14
SS-3	-	-	-	0.14
Ord	-	-	-	0.14
Comm	-	-	-	0.14

Table 5

P-3 ISD Team Personnel Costs

Rank/Rate	Designation/ Rating	Person-years	Cost ($)
Military SMEs:			
O-4	1320	8	270,072
O-3	1310	16	1,205,552
O-3	1320 (P-3B)	17	496,366
O-3	1320 (P-3C)	16	467,168
E-7	AD	3	95,370
E-7	AW	4	107,060
E-6	AW (B SS-3)	6	138,828
E-6	AW (C SS-3)	6	138,828
E-6	AW (SS-1/2)	17	393,346
E-6	AO	8	223,024
E-6	AD	10	280,340
E-5	AT	4	94,488
Subtotal			3,910,442
Military Support:			
E-5	DM	4	63,276
E-3	DM	6	71,100
Subtotal			134,376
Civilian:			
GS-11/12	--	13	700,000
TOTAL			$4,744,818

Table 6

Annual P-3 ISD Update Personnel Costs
(Years 1 Through 5)

#	Rank/Rate	Designator	Title	Billet Cost ($)
Administrative Staff:				
1	LCDR	1320	ISD Team Director	33,759
1	LCDR	1310	Ass't Team Director	69,559
1	LT	1310	Syllabus Director	75,347
1	LT	1320	Syllabus Director	29,198
Subtotal				$207,863
Adjusted Subtotal (x .58)				$120,561
Subject Matter Experts:				
1	LT	1310	B Pilot	75,347
1	LT	1310	C Pilot	75,347
3	LT	1320	B NFO	87,594
3	LT	1320	C NFO	87,594
2	AW1		B SS-1/2	46,276
3	AW1		C SS-1/2	69,414
1	AWC		B/C SS-3	26,765
1	AW1		B SS-3	23,138
1	AW1		C SS-3	23,138
1	AOC		C Ordnanceman	34,342
1/2	AO1		B Ordnanceman	13,939
1	ADCS		Flight Engineer	33,933
1	AD1		Flight Engineer	28,034
1	AT1		B Communicator	30,689
Subtotal				$655,550
Adjusted Subtotal (x .58)				$380,219
Civilian Staff:				
1	GS-11		Educational Specialist	24,200
1	GS-7		Editor	14,600
Subtotal				$38,800
ANNUAL TOTAL (Years 1 through 5)				$539,580
FIVE-YEAR TOTAL (Years 1 through 5)				$2,697,900

Table 7

Annual P-3 ISD Update Personnel Costs
(Years 6 Through 10)

#	Rank/Rate	Designator	Title	Billet Cost ($)
Administrative Staff:				
1	LCDR	1320	ISD Team Director	33,759
1	LCDR	1310	Ass't Team Director	69,559
1	LT	1320	Syllabus Director	29,198
Subtotal				$132,516
Adjusted Subtotal (x .58)				$76,859
Subject Matter Experts:				
1	LT	1310	C Pilot	75,347
3	LT	1320	C NFO	87,594
5	AW1		SS-1/2	115,690
1	AWC		SS-3	26,765
2	AW1		SS-3	46,276
1	AOC		C Ordnanceman	34,342
1	ADCS		Flight Engineer	33,933
1	AD1		Flight Engineer	28,034
Subtotal				$447,981
Adjusted Subtotal (x .58)				$259,829
Civilian Staff:				
1	GS-11		Educational Specialist	24,200
1	GS-7		Editor	14,600
Subtotal				$38,800
ANNUAL TOTAL (Years 6 through 10)				$375,488
FIVE-YEAR TOTAL (Years 6 through 10)				$1,877,440

Table 8

Annual P-3 ISD Update Personnel Costs
(Years 11 Through 15)

#	Rank/Rate	Designator	Title	Billet Cost ($)
Administrative Staff:				
1	LCDR	1320	ISD Team Director	33,759
1	LT	1310	Syllabus Director	75,347
Subtotal				$109,106
Adjusted Subtotal (x .58)				$63,281
Subject Matter Experts:				
1	LT	1310	C Pilot	75,347
2	LT	1320	C NFO	58,396
2	AW1		SS-1/2	46,276
1	AWC		SS-3	26,765
1	AW1		SS-3	23,138
1	AOC		C Ordnanceman	34,342
1	AD1		Flight Engineer	28,034
Subtotal				$292,298
Adjusted Subtotal (x .58)				$169,533
Civilian Staff:				
1	GS-11		Educational Specialist	24,200
1	GS-7		Editor/Writer	14,600
Subtotal				$38,800
ANNUAL TOTAL (Years 11 through 15)				$271,614
FIVE-YEAR TOTAL (Years 11 through 15)				$1,358,070

Table 9

Summary of ISD Maintenance/Update Personnel Costs ($)
(from Tables 6, 7, and 8)

	Years 1-5	Years 6-10	Years 11-15	GRAND TOTAL
ISD Update/ Maintenance Cost	2,697,900	1,877,440	1,358,070	$5,933,410

Table 10

ISD Costs Worksheet

Assumed Life Cycle of System: 15 Years

	Procurement Costs ($)	Projected Personnel Costs ($)	Projected Nonpersonnel Costs ($)
Contractor	2,948,000	--	--
Military SME	3,910,000	4,048,000	--
Military Support	134,000	1,303,000	--
Government Civilian	700,000	582,000	--
Instructional Software	270,000	--	--
Total for 2 FRSs	7,962,000	5,933,000	--
TOTAL FOR MOFFETT FIELD	3,981,000	2,967,000	--
		GRAND TOTAL	$6,948,000

Table 11

Life Cycle Cost of Learning Center Instructors

Crew Position	Life-cycle Student Load	Learning Center Hours	Instructor Cost/Hr($)	Total Cost ($)
Pilot	2700	248	2.32	1,553,472
NFO	1800	386	1.35	937,980
FE	2100	265	1.11	617,715
SS-1/2	1800	236	1.07	454,536
SS-3	900	154	1.72	238,392
Ord	1800	44	0.86	68,112
Comm	600	130	3.28	255,840
TOTAL				$4,126,047

Table 12

Learning Center Staff Support Costs

Grade/Rate	#	Annual Salary	Overhead	Total ($)
Graphics Personnel:				
GS-9	1	18,739	10%	20,613
GS-7	4	15,317	10%	67,395
GS-5	2	12,368	10%	27,210
GS-4	1	11,054	10%	12,159
Printer/Reproduction Personnel:				
LI-2	3	15,567	Incl.	46,701
SN	2	11,848	Incl.	23,696
Learning Center Staff:				
GS-5	1	12,368	10%	13,605
GS-4	1	11,054	10%	12,159
GS-3	1	9,846	10%	10,831
GS-2	2	8,902	10%	19,584
YN-2	1	15,347	Incl.	15,347
AZ-3	1	14,971	Incl.	14,971
AA	3	13,878	Incl.	41,634
			ANNUAL TOTAL:	$325,905
			LIFE CYCLE TOTAL (x15):	$4,888,575

Table 13

Facilities Costs Worksheet

Assumed Life Cycle of System: 15 Years

	Procurement Costs ($)	Projected Personnel Costs ($)	Projected Nonpersonnel Costs ($)
Building Construction/ Modification	400,000	--	--
Facilities Equipment	200,000	--	--
Instructors	--	4,126,000	--
Facilities Staff	--	4,889,000	--
Consumables	--	--	900,000
TOTAL	600,000	9,015,000	900,000
		GRAND TOTAL	$10,515,000

Table 14

Training Device Acquisition and Operating Costs

Trainer	Unit Price	FY 1979 Operating Cost	FY 1979 Operating Hours	Acquisition Cost/Hr.*	Operating Cost/Hr.
2F87(F)	2 x $4,278,760**	$326,083	8,756	$65	$37
2F87(T)	2 x 4,646,882**	277,608	8,023	77	35
14B40	2,081,970	89,607	1,512	92	59
14B44	2,764,113	98,323	2,526	73	39
2C45	1,232,740	57,078	1,423	58	40
2F69E	4,270,000	321,311	3,139	91	102
TOTAL ACQUISITION COST:					$28,200,107
TOTAL ANNUAL OPERATING COST					$1,170,010
TOTAL LIFE-CYCLE OPERATING COST (x15):					$17,550,150

* For 15 year life cycle, based on FY 1979 usage rate
** 2 devices each at Moffett Field

Note: Some obsolete devices are not included here due to lack of data (e.g., 15Z1, 15E16).

Table 15

Cost of Training Device Session Instructors

Position	Life Cycle Student Load	Training Device Hours	Instructor Cost/Hr ($)	Total Cost ($)
1st Tour Pilot	2250	82	20.93	3,861,585
2nd Tour Pilot	450	71	20.93	668,714
B NFO	600	69	16.22	671,508
C NFO	1200	74	16.22	1,440,336
Flight Engineer	2100	44	7.79	719,796
B SS-1/2	600	121*	3.21	233,046
C SS-1/2	1200	118*	3.21	454,536
B SS-3	300	84*	5.18	130,536
C SS-3	600	100*	5.18	310,800
TOTAL				$8,490,857

* Figures adjusted for different instructor/student ratios in some training devices

Table 16

Training Device Costs Worksheet

Assumed Life Cycle of System: 15 Years

	Procurement Costs ($)	Projected Personnel Costs ($)	Projected Nonpersonnel Costs ($)
Equipment Acquisition	28,200,000	--	--
Instructors	--	8,491,000	(Note 1)
Device Maintenance Personnel	--	17,550,000	--
Device Operation	--	(Note 1)	--
Device Modification/Update	--	--	--
Spare Parts	--	--	(Note 1)
TOTAL	28,200,000	26,041,000	--
		GRAND TOTAL	$54,241,000

Note 1: All training device maintenance & operation expenses are included together under device maintenance personnel expenses.

Table 17

Cost of Aircraft Session Instructors

Position	Life Cycle Student Load	Aircraft Device Hours	Instructor Cost/Hr ($)	Total Cost ($)
1st Tour Pilot	2250	95	41.85	8,945,438
2nd Tour Pilot	450	50	41.85	941,625
B NFO	600	91	16.22	885,612
C NFO	1200	81	16.22	1,576,584
Flight Engineer	2100	115	7.79	1,881,285
B SS-1/2	600	56	6.42	215,712
C SS-1/2	1200	65	6.42	500,760
B SS-3	300	96	5.18	149,184
C SS-3	600	95	5.18	295,260
B Ordnance	600	75	5.17	232,650
C Ordnance	1200	70	5.17	434,280
B Communicator	600	98	6.57	386,316
TOTAL				$16,444,706

Table 18

Aircraft Flight Hour Costs

Position	Life Cycle Student Load	Flight Hours Per Student	Proportion of Flight Hr/Student	Total Student Hours
1st Tour Pilot:				
Phase B	2250	20	0.50	22,500
Phases C, D	2250	75	0.14	23,625
2nd Tour Pilot:				
Phase B	450	15	0.50	3,375
Phases C, D	450	35	0.14	2,205
B NFO	600	70	0.14	5,880
C NFO	1200	54	0.14	9,072
Flight Engineer:				
Phase B	2100	40	0.50	42,000
Phases C, D	2100	64	0.14	18,816
B SS-1/2	600	36	0.14	1,680
C SS-1/2	1200	30	0.14	5,880
B SS-3	300	70	0.14	1,092
C SS-3	600	70	0.14	2,100
B Ordnance	600	24	0.14	1,512
C Ordnance	1200	24	0.14	2,520
B Communicator	600	30	0.14	4,284
Subtotal				146,541
(times cost per hour - see text)				(x $2431)
TOTAL				$356,241,171

Table 19

Aircraft Lab Hour Costs

Position	Life Cycle Student Load	A/C Lab Hours Per Student	Proportion of A/C Lab Hr/Student	Total Student Hours
Pilot	--	--	--	--
B NFO	600	21	1.0	12,600
C NFO	1200	27	1.0	32,400
Flight Engineer	--	--	--	--
B SS-1/2	600	20	0.5	6,000
C SS-1/2	1200	35	0.5	21,000
B SS-3	300	26	0.5	3,900
C SS-3	600	25	0.5	7,500
B Ordnance	600	18	0.5	5,400
C Ordnance	1200	15	0.5	9,000
B Communicator	600	51	0.5	15,300
Subtotal				113,100
(times cost per hour - see text)				(x $1480)
TOTAL				$167,388,000

Table 20

AET Costs Worksheet

Assumed Life Cycle of System: 15 Years

	Procurement Costs ($)	Projected Personnel Costs ($)	Projected Nonpersonnel Costs ($)
Equipment Acquisition	(Note 1)	--	--
Instructors	--	16,445,000	--
Maintenance Personnel	--	(Note 2)	--
Maintenance Parts and Consumables	--	(Note 2)	523,629,000
TOTAL	--	16,445,000	523,629,000
		GRAND TOTAL	$540,074,000

Note 1: Aircraft acquisition costs were not included.
Note 2: Aircraft maintenance personnel costs were not included.

Table 21

Student Costs Worksheet

Assumed Life Cycle of System: 15 Years

	Number of Students	Annual Student Cost ($)	Percent of Year in Training	Total ($)
1st Tour Pilot (Ensign)	2250	35,770	40	32,193,000
2nd Tour Pilot (LCDR)	450	85,920	34	13,146,000
NFO (Ensign)	1800	29,930	38	20,472,000
FE (AD3)	2100	16,277	40	13,672,000
SS-1/2 (AW3)	1800	20,680	31	11,540,000
SS-3 (AW3)	900	20,233	24	4,370,000
Ordnance (AO3)	1800	15,869	13	3,713,000
Communicator (AT3)	600	31,684	26	4,942,000
			TOTAL	$104,048,000

Table 22

Total Training Costs Worksheet

	Procurement Costs ($)	Projected Personnel Costs ($)	Projected Other Costs ($)	Total ($)
ISD Costs	3,981,000	2,967,000	--	6,948,000
Facilities Costs	600,000	9,015,000	900,000	10,515,000
Training Device Costs	28,200,000	26,041,000	(Note 1)	54,241,000
AET Costs	(Note 1)	16,445,000	523,629,000	540,074,000
Student Costs	--	104,048,000	--	104,048,000
TOTAL	32,781,000	158,516,000	524,529,000	$715,826,000

Note 1: Costs in these categories were excluded from consideration in the model.

Table 23

Relative P-3 FRS Aircrew Training Costs

Training System Component	Cost ($)	% of Total Cost
ISD	6,948,000	1.0
Facilities	10,515,000	1.5
Training Devices *	54,241,000	7.6
AET *	540,074,000	75.4
Students	104,048,000	14.5
TOTAL	$715,826,000	100.0

* Some costs in this category were omitted from consideration.